Report for 2004DE46B: Undergraduate Internship: Design and Field Testing of Advanced Surveillance Systems for Delaware's Shallow Depth Estuaries

- Water Resources Research Institute Reports:
  - Glancey, James, Matthew King, 2005, Design and Field Testing of Advanced Surveillance Systems for Delaware's Shallow Depth Estuaries, Delaware Water Resources Center, University of Delaware, Newark, Delaware, 3 Pages.

Report Follows

Undergraduate Internship Project #6 of 9 for FY04

Matt King is studying the "Design and Field Testing of Advanced Surveillance Systems for Delaware's Shallow Depth Estuaries" in his internship co-sponsored by DWRC and the Delaware Department of Natural Resources and Environmental Control (DNREC). His advisor is Dr. James Glancey of the University of Delaware Departments of Bioresources Engineering and Mechanical Engineering in the Colleges of Agriculture and Natural Resources and Engineering

"My efforts have been iterative and evolving, and I learned that a project of this scope is a real challenge. I look forward to passing on what I have learned with the goal of continued improvement of the design of this water quality monitoring system." -- Matt King

Abstract:

A cooperative effort between the University of Delaware and DNREC has led to the development of a low cost monitoring station that is capable of measuring whole water column water quality data throughout the entire depth of a water body. The device utilizes the data sondes currently in owned by DNREC. As configured, the monitoring station following parameters can be measured: water quality variables [water temperature, pH, dissolved oxygen, and turbidity] and meteorological variables (air temperature, relative humidity, barometric pressure, incident solar radiation, wind speed and direction, rain gauge). The resulting information provides a complete snapshot of important water quality data – over a period of time, the data provides a comprehensive understanding of water quality changes in a body of water throughout the entire depth. In addition, the monitoring station is equipped with cellular telemetry which transmits the data to a host computer that can broadcast the data on the web in real time; data can also be processed and sent to a list of scientists and other personnel for further analysis.

This technology provides a unique and effective means to monitor estuarine waters with high temporal resolution, which is critical for an effective Harmful Algal Bloom (HAB) detection. The goal of this project is to deploy a monitoring station for extended testing in the Inland Bays and to begin to understand, in cooperation with DNREC's Environmental Laboratory, water quality dynamics throughout the entire water column during critical periods of the 2004 summer season. The continuously recorded results from the monitoring station will promote a better understanding of the influences of nutrient enrichment on HAB dynamics, assist in determining the temporal relationships between HABs and shellfish health/toxin contamination, and provide an early warning system for the detection of HABs in one of Delaware's prime recreational waters.

Project Objectives:

1) Deploy and fully support the prototype whole water column monitoring station from June through September, 2004, in cooperation with DNREC. The site location will be chosen by DNREC, and if possible, will accommodate whole-water column testing.
2) Design and field test a small DGPS-guided, self-propelled, mobile water craft that utilizes the technology already developed for whole-water column sampling.
3) Complete a Degree with Distinction Thesis using the data collected during the summer as well as the design and testing of the mobile water craft sampling device.

Project Methods:

The first goal of this project is to conduct the first set of extended field tests with the exiting fixed dock monitoring station. To accomplish this, the prototype monitoring system will be deployed at a location in the Delaware Inland Bays chosen by personnel at DNREC based on data that demonstrates recent algae bloom activity, fish kills, oxygen deficits, and a potential threat to Delaware's recreational approved shellfish areas. Throughout the test period from June though September, data will be available from the monitoring station to complement current HAB monitoring programs. During this time period, design improvements for the station will be incorporated, both for the hardware and software. By the end of the test period in September, the goal is for personnel at both DNREC and U of D to develop sufficient confidence in this new method of monitoring so that a more extensive sampling program can be implemented in 2005. To accomplish this, regularly scheduled review meetings during the summer will be conducted at DNREC. The purpose of these monthly meeting will be to review the performance of the monitoring station, compare data collected with the station to data from other sampling activities by DNREC, and re-evaluate and update the plan for the remainder of the sampling season. In addition to the meetings, at least one field demonstration will be conducted at the sampling site for DNREC personnel. To reduce the potential for damage or theft during the sampling season, a 'dummy' monitoring station will be fabricated in May. The dummy device will be deployed at the testing site until the actual monitoring station is installed at the beginning of June.

A second goal of the project is the design and testing of a mobile sampling platform capable of automatic guidance within a water body. The primary advantage of this system will be to provide improved spatial resolution of several key water quality variables, not only throughout the water column, but also with respect to length and width of a creek, pond, river or bay. This attribute will be very important in understanding why and how some water bodies are prone to fish kills. For example, the mobile sampling platform will provide the ability to monitor several creeks within the Inland Bays Watershed that are know to have highly variable water depths – unlike the stationary fixed dock platform, the mobile sampler will allow researchers to examine how, for example, dissolved oxygen dynamics are influenced by varying water depth within a water body. By using the mobile sampler to traverse and sample a water body over time, the spatial variations and temporal changes can be quantified for the first time in Delaware.

To achieve this second goal, work will begin the latter part of the summer to design a small DGPS-guided, self-propelled, mobile water craft. The current technology developed for the fixed dock sampler (described previously) will be integrated into the water craft. The on-board microprocessor will be used for guidance control, with the addition of a DGPS receiver. Two different navigation strategies will be examined: 1) teach-and-play and 2) fixed-path trajectory using predefined GPS way points. In the teach-and-play mode, an operator would "teach" the device the path it is to follow by using a remote control. While being navigated through this path, the mobile water craft will record GPS points along the way – after completing the path one time, the device can then follow the path and operate on its own without a user. In the fixed-path trajectory approach, a handheld GPS receiver can be used to create a path using known "waypoints" – the set of waypoints can then be downloaded into the mobile sampling craft, and the device can traverse the path on it own. With either approach, once a path has been defined, the mobile water craft will be programmed remotely to traverse the path a regular intervals, both night and day. The device will stop at the predefined sampling locations along the path and record whole water column as well as meteorological data. Data will be transmitted via the on-board cellular modem once the system has traversed the entire path. The near real-time data will be displayed on a U of D website for DNREC and other personnel to review.